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Time and cost competitiveness of inland waterway transport in relation to alternative modes of transport for hinterland of the Szczecin–Świnoujscie port complex (case studies)

JEL codes: R41, O18

Keywords: inland navigation, waterway transport, Szczecin–Świnoujście Port Complex

Abstract: The article presents the analysis of competitiveness of time and cost of carriage charges by three transport branches: road, rail, and inland navigation. The authors tried to take into consideration all costs involved in transporting a particular type of cargo for different branches of transport. The cost of transportation and cargo handling costs are adopted in force at April 2015. The authors try to prove by what class of waterways, inland navigation would become competitive with other branches of transport.

Introduction

Ports complex of The Lower Oder estuary has a direct connection via the Oder river and the Oder – Havel Canal to the Western Europe waterway network. It is the only shipping way in Poland which hosts a regular shipping freight (after the suspension of coal transport on the route Gliwice–Wroclaw in 2012). The transport of goods from the river basin of the Oder river could be directed to the ports of Szczecin and Świnoujście (Wiśnicki 2013). Many years of neglect resulting from the lack of financial resources necessary to maintain the river have reduced the depth of the transit especially in the middle section of the Oder. The article presents the analysis of competitiveness of time and cost of carriage

charges by three transport branches: road, rail, and inland navigation. The analysis was performed for five transportation options. The analyzed variants of potential cargoes and transport routes consider relations with the sea ports of Szczecin and Świnoujście. Assumptions of the analysis:

1. The proposed variants were adopted on the basis of the existing infrastructure point.
2. The cost of transportation and cargo handling costs are adopted in force at April 2015.
3. Means of transport by road and rail, and their parameters have been selected (depending on the cargo) currently available on the market. Their technical parameters have been characterized in descriptions of various options.
4. For inland navigation it was assumed to use push-convoys consisting of push--ship and push-barges BP-500 or SL (a maximum draft of 216 cm) which are mainly used for transport on the Oder river. Depending on the class of waterway adopted:
   a) current state of the waterway – draft permitted 120 cm – push-ship Bizon + 2x push-barge BP 500 (63% of capacity);
   b) current state of the waterway – the draft permitted 130 cm, push-ship Bizon + 2x push-barge BP 500 (71% of capacity);
   c) III class of waterway – the draft permitted 160 cm, push-ship Bison + 2x push-barge BP 500 (100% of capacity);
   d) IV class of waterway – the draft permitted 216 cm, push-ship Bison + 3x push-barge SL (Ger. Schubleichter – 100% of capacity). For IV class of waterway (guaranteed transit depth of 280 cm), draft permitted is 260 cm. This option gives the possibility to use other solutions than the commercially available push-barges or motor-barges. Due to the lack of such units on the part of Polish shipowners, they were not included in the study.
5. The costs of inland water transport for variants with a draft of 120 cm and 130 cm (current state) additionally include the costs of reaching by an empty vessel the place of loading or of an empty return (except variant III). In the variants with a draft of 160 cm (III class of waterway) and 260 cm (IV class of waterway), as well as for other modes of transport, such costs were not included because of the high possibility of obtaining return freight.
6. The costs of transport to/from the port of loading or the railway station, and handling costs depend on the distance to which such services must be performed.
7. The costs of rail transport include a discount for large shipments. The discount can be changed each time due to the changes in the transport policy of railway companies.
8. Transportation time is specified in decimal in days with an accuracy of one decimal place.
9. For container transportation, it is assumed to use 20’ container. In road transport,

one should only take into account the reduction of the maximum permissible mass for the transportation of two containers of 20'.

1. Variant I – transport of granulated fertilizers on the route Kędzierzyn-Koźle–Szczecin

The first variant assumed the transports of granulated fertilizers on the route Kędzierzyn-Koźle–Szczecin. In road transport, a standard set trailer of "Benalu" with a capacity of 24 t was adopted. In rail transport, included a set with a capacity of 1400 t with a four-axis self-unloading wagons "Tadds" (430s-Bg, four-chamber) designed for the transport of bulk materials sensitive to weather conditions (24 pieces after 58 t). In inland waterway transport, pushed convoys with closed holds were adopted.

Journey times have been determined by the carriers. In the road transport, average speed of 50 km/h is assumed, whereas in railway transport – 20–30 km/h (Wiśnicki and Dyrda 2016). The inland waterway transport for the current state considered a waste of time to travel empty in one direction. With the increase of the class of waterway to class III and higher, this time was not included due to the profitability of carrying other cargo on the way back.

In the adopted variant, the shipping distance for each mode of transport varies from 485 km by rail to a 650 km by inland shipping. The biggest load capacity is offered by rail transport – 1,400 t, whereas the lowest – 24 t – by road transport. In inland navigation, the load capacity depends on the draft, from 600 t – at the draft up to 120 cm, till 1,250 t after the modernization of waterway to IV or higher class of waterway (Wiśnicki, Jędrzychowski and Jędrzychowski 2015)

Table 1. Variant I – transport of granulated fertilizers on the route Kędzierzyn-Koźle–Szczecin

Variant I	Road transport	Railway transport	Inland navigation			
			Current state – draft to 120 cm	**Current state – draft to 130 cm**	**upgrading to III waterway class – draft to 160 cm**	**upgrading to IV waterway class – draft to 260 cm**
1	2	3	4	5	6	7
capacity (metric ton)	24 t	1,400 t	600 t	670 t	950 t	1,250 t
cost of transportation to / from the inland port (railway station)	–	–	–	–	–	–
1	2	3	4	5	6	7

cost of handling	–	–	–	–	–	–
transport distance	520 km	485 km	650 km	650 km	650 km	650 km
cost of transport	65 PLN/t	198.40 PLN/t	96 PLN/t	86 PLN/t	33 PLN/t	25 PLN/t
discount	–	60%	–	–	–	–
cost after discount	65 PLN/t	79 PLN/t	96 PLN/t	86 PLN/t	33 PLN/t	25 PLN/t
AMOUNT	1,560 PLN	110,600 PLN	57,600 PLN	57,600 PLN	31,600 PLN	31,600 PLN
estimated time of transport [day]	0.4 day	2 days	15 days	15 days	7 days	7 days

Source: own elaboration – road transport based on the current market rates based on telephone surveys to trucking carriers; railway transport – based on the tariff of PKP Cargo and catalogue of distances and discounts for regular customers and large batches of goods; inland navigation – based on a telephone survey to shipowners.

The cost of transport per 1 t is diverse – from 25 PLN/t to 96 PLN/t. With the current state of waterways, inland navigation is unprofitable, but after raising the waterway class barge transport, the cost is about 50–60% (depending on the class of the waterway) lower than in the case of the road transport.

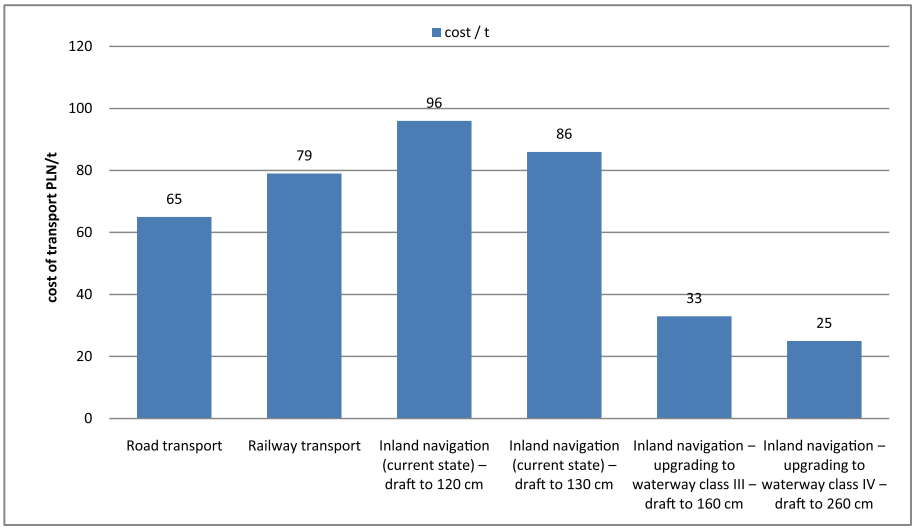

Fig. 1. Variant I – comparison of transport costs per 1 t

Source: own elaboration.

2. Variant II – coal transportation on the route Gliwice–Szczecin

In the second variant, we analyzed the costs and time of coal transport from a coal mine in Dabrowa Górnicza through the port in Gliwice (for waterway variants) to the port of Szczecin. The parameters of vehicles for road and rail transport change depending on the type of the transported goods. In the road transport, semi-trailers "bath" with a capacity of 24 t were assumed to be used. In the railway transport, wagons used a "coal carriage" with the capacity of 60 t. In the composition of heavy transport, consisting of 40 pieces of wagons, 55 t each, the total loading capacity is 2,200 tons. The inland waterway transport parameters remain basically the same as in the first variant. Barges in the case of this type of cargo can remain open – they do not need to be covered with hatch covers.

The shortest transport distance and at the same time the largest capacity occurs in the case of the rail transport through Gliwice to Szczecin. In addition, the price drop is granted more favorable from those used at the present maximum draft of inland vessels. If the modernization of waterways up to class III was made, relatively large load capacity at a much lower cost would make the inland option more favorable. And by far the best option would be to transport cargo by waterways class IV at an estimated cost of individual row twice lower compared to the railways or transport vehicles.

Table 2. Variant II – coal transportation on the route Gliwice–Szczecin

Variant II	Road transport	Railway transport on route Dabrowa Gornicza–Szczecin	Railway transport on route Dabrowa Gornicza–Gdańsk	Inland navigation			
				Current state – draft to 120 cm	**Current state – draft to 130 cm**	**upgrading to III waterway class – draft to 160 cm**	**upgrading to IV waterway class – draft to 260 cm**
1	2	3	4	5	6	7	8
capacity (metric ton)	24 t	2,200 t	2,200 t	600 t	670 t	950 t	1,250 t
cost of transportation to / from the inland port (railway station)	–	–	–	11.0 PLN/t	11.0 PLN/t	11.0 PLN/t	11.0 PLN/t
cost of handling	–	–	–	5.0 PLN/t	5.0 PLN/t	5.0 PLN/t	5.0 PLN/t
transport distance	550 km	512 km	590 km	680 km	680 km	680 km	680 km
cost of transport	68.75 PLN/t	198.40 PLN/t	211.88 PLN/t	111 PLN/t	98 PLN/t	42 PLN/t	33 PLN/t

1	2	3	4	5	6	7	8
discount	–	75%	75%	–	–	–	–
cost after discount	68.75 PLN/t	50 PLN/t	53 PLN/t	111 PLN/t	98 PLN/t	42 PLN/t	33 PLN/t
AMOUNT	1,650 PLN	110,000 PLN	116,600 PLN	76,200 PLN	76,380 PLN	55,100 PLN	61,250 PLN
estimated time of transport [day]	0.3 day	2 days	2 days	17 days	17 days	9 days	9 days

Source: own elaboration – road transport based on the current market rates based on telephone surveys to trucking carriers; railway transport – based on the tariff of PKP Cargo and a catalog of distances and discounts for regular customers and large batches of goods; inland navigation – based on a telephone survey to shipowners.

This variant includes also the cost of transport on the route Dąbrowa Górnicza–Gdańsk in order to provide an alternative transport corridor. In the present case, the cost of rail transport to the port of Szczecin and Gdańsk is practically the same. The cost of transporting coal by barge afforded to III or IV class of waterway is lower than 20% to nearly 40% from transport by rail. Modernisation of the Odra River, beyond the transfer cargo on river can result in transfer direction of cargo handled so far to ports of Trójmiasto.

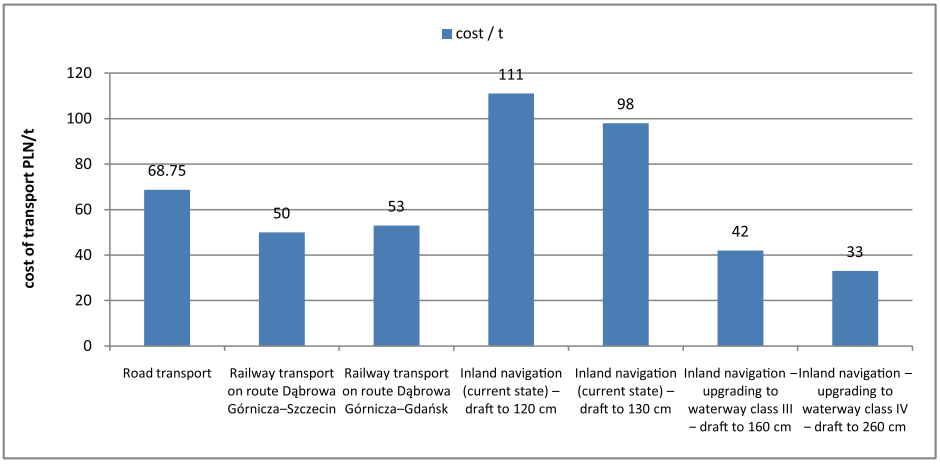

Fig. 2. Variant II – comparison of transport costs per 1 t

Source: own elaboration.

3. Variant III – coal transportation on the route Szczecin–Wrocław

In variant III, the transport of coal from Szczecin to Wroclaw was analysed, where the distance depending on the route varies from 400 km (car/rail) to 490 km by inland navigation. In this variant, unlike in the others, the cost of transport by barge at the current state of infrastructure, do not include the cost of carriage on empty. This assumption stems from the fact that it is not a problem to find return loads transported down the river. As compared to option II, despite a shorter distance, the cost of carriage by rail has not changed by more than 20%. For all other methods of transport, the cost is reduced accordingly. In this, as well as in the previous variant, barge transportation is beneficial only after upgrading waterway to at least class III. However, transport is many times greater than in other sectors.

Table 3. Variant III – transport of coal from Szczecin to Wrocław

Variant III	Road transport	Railway transport	Inland navigation			
			Current state – draft to 120 cm	**Current state – draft to 130 cm**	**upgrading to III waterway class – draft to 160 cm**	**upgrading to IV waterway class – draft to 260 cm**
capacity (metric ton)	24 t	22,000 t	600 t	670 t	950 t	1,250 t
cost of transportation to/from the inland port (railway station)	–	–	–	–	–	–
cost of handling	–	–	7 PLN/t	7 PLN/t	7 PLN/t	7 PLN/t
transport distance	400 km	512 km	490 km	490 km	490 km	490 km
cost of transport	48.75 PLN/t	198.40 PLN/t	72 PLN/t	63 PLN/t	34 PLN/t	25 PLN/t
discount	–	75%	–	–	–	–
cost after discount	48.75 PLN/t	50 PLN/t	72 PLN/t	63 PLN/t	34 PLN/t	25 PLN/t
AMOUNT	1,170 PLN	110,000 PLN	47,400 PLN	46,900 PLN	38,950 PLN	40,000 PLN
estimated time of transport [day]	0.3 day	2 days	9 days	9 days	8 days	8 days

Source: own study – road transport based on the current market rates based on telephone surveys to trucking carriers; railway transport – based on the tariff of PKP Cargo and a catalog of distances and discounts for regular customers and large batches of goods; inland navigation – based on a telephone survey to shipowners.

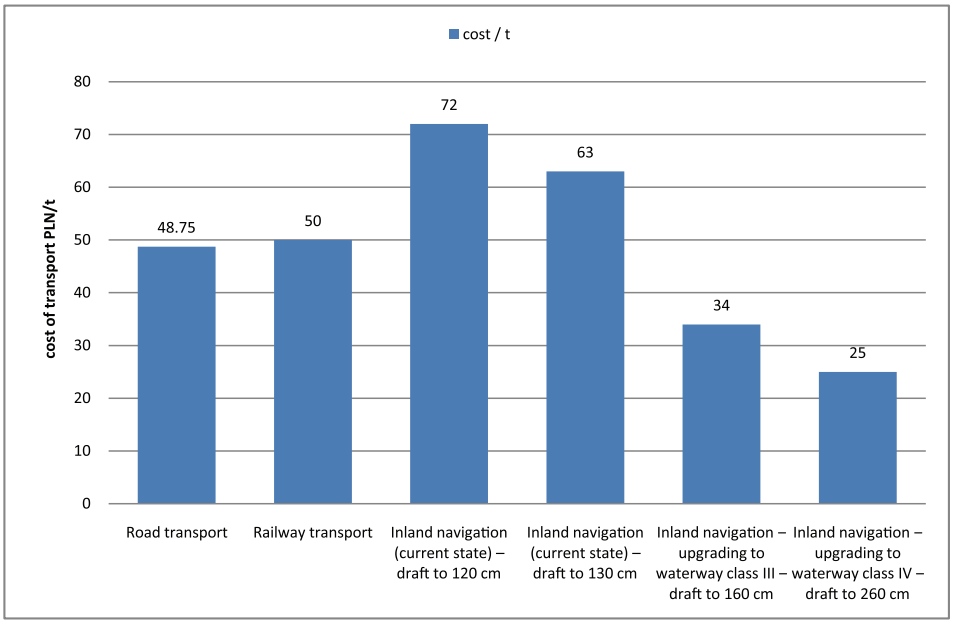

Fig. 3. Variant III – comparison of transport costs per 1 t

Source: own elaboration.

4. Variant IV – transport of cellulose between Szczecin and Kostrzyn nad Odrą

In variant IV, the transport of cellulose between Szczecin and Kostrzyn nad Odrą has been analyzed. Due to the nature of the cargo in road transport, curtain semi-trailer with a load capacity of 24 tonnes is used, however, a real use of this means of transport oscillates around 18 tonnes. On rail transport, 24 wagons of covered type "Hais" were used with a capacity of 50 tonnes, giving a total load capacity of 1,000 tonnes. On the inland waterway transport, due to the fact that Kostrzyn nad Odrą has at the moment III class of waterway, it is possible to use, instead of barges BP-500, a larger type of barges BP-800, with a larger capacity without changing the parameters of draft. For IV class of waterway, two barges BP-800 were used with raised coaming. Hypothetically, one can apply a set of four barges with a capacity of about 2500–3000 tonnes, but it is uncertain whether there would be demand for such large batches of cargo.

Table 4. Variant IV – transport of cellulose between Szczecin and Kostrzyn nad Odrą

Variant IV	Road transport	Railway transport	Inland navigation			
			Current state – draft to 120 cm	**Current state – draft to 130 cm**	**upgrading to III waterway class – draft to 160 cm**	**upgrading to IV waterway class – draft to 260 cm**
capacity (metric ton)	24 t	1,000 t	680 t	800 t	1,100 t	1,600 t
cost of transportation to / from the inland port (railway station)	–	–	–	–	–	–
cost of handling	–	–	7 PLN/t	7 PLN/t	7 PLN/t	7 PLN/t
transport distance	120 km	100 km	125 km	125 km	125 km	125 km
cost of transport	27.70 PLN/t	64.04 PLN/t	27.5 PLN/t	23 PLN/t	10PLN/t	6.8 PLN/t
discount	–	45%	–	–	–	–
cost after discount	27.70 PLN/t	30 PLN/t	27.5 PLN/t	23 PLN/t	10 PLN/t	6.8 PLN/t
AMOUNT	500 PLN	35,200 PLN	23,460 PLN	24,000 PLN	18,700 PLN	22,080 PLN
estimated time of transport [day]	0.3 day	2 days	9 days	9 days	8 days	8 days

Source: own study – road transport based on the current market rates based on telephone surveys to trucking carriers; railway transport – based on the tariff of PKP Cargo and a catalog of distances and discounts for regular customers and large batches of goods; inland navigation – based on a telephone survey to shipowners.

At a comparable distance transport (ranging from 100 to 125 km), the cost transportation per 1 tonne is very diverse. On railway transport, despite the discount (for this distance amounting to 45%), the cost is nearly five times higher than in the case of inland waterway transport with class IV waterway. Also, in terms of the capacity, it remains the most competitive inland waterway. At this distance, the estimated transport time is shorter than the rail waterway.

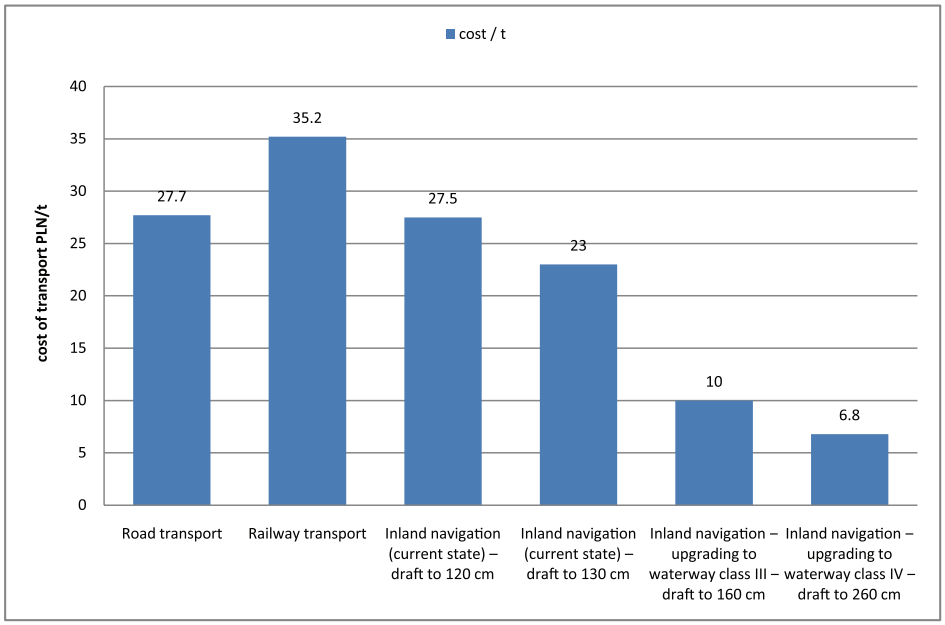

Fig. 4. Variant IV – comparison of transport costs per 1 t

Source: own elaboration.

5. Variant V – transport of containers on the route Świnoujście–Wrocław

Unitary goods in container transport requires the adoption of other criteria. For cost analysis, the transport of one 20'-container was adopted. It should be noted, however, that during the transport of a container by road with a maximum weight of 20'-container 22 tonnes, it is possible to exceed the maximum total weight of the car kit. The load capacity of rail transport is set at 60 20'-containers (30 wagons with two containers on each).

The estimation of the cost includes transportation to the place of loading, transport, and handling costs. On inland waterway, the transport of containers is provided by means of a set of pushed/pusher type Bison + 2 x SL (Ger. Schubleichter) (one large barge SL with a length of 67 m and one small SL with a length of 33.5 m increased width allowing the user to 3 containers width of 7.5–8 m. In one layer 12 + 24 = 36 TEU, two 36 x 2 = 72 TEU). This kind of container transport by barge is implemented, for example, at Elbe river.

Table 5. Variant V – transport of containers on the route Świnoujście–Wrocław

Variant V	Road transport	Railway transport	Inland navigation			
			Current state – draft to 120 cm	**Current state – draft to 130 cm**	**upgrading to III waterway class – draft to 160 cm**	**upgrading to IV waterway class – draft to 260 cm**
capacity (metric ton)	2 x 20’	60 x 20’	26 x 20’	26 x 20’	38 x 20’	72 x 20’
cost of transportation to / from the inland port (railway station)	–	400 PLN per unit	400 PLN per unit	400 PLN per unit	400 PLN per unit	400 PLN per unit
cost of handling	290 PLN	290 PLN per unit	290 PLN per unit	290 PLN per unit	290 PLN per unit	290 PLN per unit
transport distance	500 km	455 km	555 km	555 km	555 km	555 km
cost of transport	750 PLN/20’	3,040 PLN/20’	2,080 PLN/20’	2,080 PLN/20’	900 PLN/20’	470 PLN/20’
discount	–	75%	–	–	–	–
cost after discount	750 PLN/20’	760 PLN/20’	2,080 PLN/20’	2,080 PLN/20’	900 PLN/20’	470 PLN/20’
AMOUNT	2,080 PLN	87,000 PLN	72,020 PLN	72,020 PLN	60,420 PLN	83,520 PLN
estimated time of transport [day]	0.4 day	2 days	12 days	12 days	7.5 days	7.5 days

Source: own study – road transport based on the current market rates based on telephone surveys to trucking carriers; railway transport – based on the tariff of PKP Cargo and a catalog of distances and discounts for regular customers and large batches of goods; inland navigation – based on a telephone survey to shipowners

The number of containers transported depends on the maximum draft, which determines the parameters of waterway. At its present state, it is possible to transport 26 containers and not to exceed the weight of 300 tonnes per one barge. With greater immersion load capacity increased up to 72 containers per transport, waterways were upgraded to IV class of waterway.

Extra costs should include the cost of handling and the cost of transportation to or from the inland waterway port or the train station where loading is carried out. On inland waterway, in the first two options, the cost is high because it includes additional fees for returning the ship with empty cargo holds or with empty containers. These costs are not included in III and IV class of waterway, where another return transportation would be carried out.

At the present moment, the transport of containers by inland navigation is unprofitable. Only raising the class of waterway to at least IV and the realization of return transport gives a competitive edge to inland waterway transport.

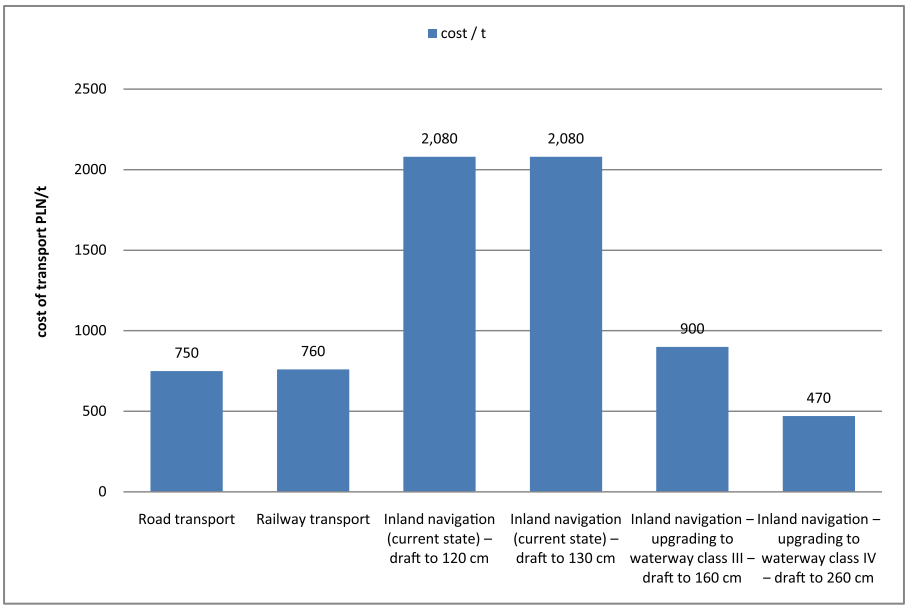

Fig 5. Variant V – comparison of transport costs per 1 t

Source: own elaboration.

Summary

Based on this analysis, we can draw the following conclusions:

1. In each of the inland waterway transport competitiveness variants, it is possible to be profitable only after the modernization of the Oder River to the third and upper-class of waterway.
2. Currently, due to the low demand for transport by inland waterway, while planning the transport, the cost of returning vessel on empty should be taken into consideration. Most often, in such a case, services are not profitable and therefore uncompetitive.
3. In the perspective of raising the quality of waterways, it should be considered to bring or build new ships with higher capacity and draft. At class IV of waterway, the transit depth is 280 cm (safe operating depth would be maximum 260 cm). In Poland, the most frequently used for inland ships is a pushed system. In Germany, ships are self-propelled and pushed convoys occur mainly on the Rhine. Standard barge "Reńska" is "Europe Class-2" with a capacity of 2500–3000 tons. Currently,

on Polish market, there are several units of barge type BP-800 (with a capacity of about 850, and draft 219 cm), and several units of type SL-42xx (with a capacity of 950 tonnes and draft 216 cm). At the moment, pushed barge designed to be used on IV class of waterway are not available on the Polish market.

4. In the perspective of the next few years, it is expected to improve the conditions of transport by rail (currently the average speed is 26 km/h and is planned to be 60 km/h) and the increase in the prices of transport vehicles (increase in fees for the use of roads, fuel prices).
5. The competitiveness of rail is conditioned by the increase of flexibility in shaping the train schedules of PKP Cargo. Currently, the relatively rigid policy in this area allows changes with 3 months in advance. On the other hand, new transport companies appear on the Polish market, which are more flexible in this area.

References

Wiśnicki, B. (2013). The concept of inland shipping service to the Container Terminal Świnoujscie. *Scientific Journals of Maritime University of Szczecin*, *35* (107), 161–167.

Wiśnicki, B., Dyrda, A. (2016). Analysis of the intermodal transport efficiency in the Central and Eastern Europe. *Naše More – International Journal of Maritime Science & Technology*, *63* (2), 43–47.

Wiśnicki, B., Jędrzychowski, K., Jędrzychowski, H. (2015). *Conditions for the preparation of the complex transport infrastructure investment illustrated by the Lower Vistula River revitalization* (pp. 339–348). Proceedings of the International Scientific Conference for PhD. Students and Young Scientists MERKÚR 2015, Virt, Slovkia, 3–4.12.2015.

KONKURENCYJNOŚĆ CZASOWA I KOSZTOWA TRANSPORTU WODNEGO ŚRÓDLĄDOWEGO W STOSUNKU DO ALTERNATYWNYCH FORM OBSŁUGI ZAPLECZA ZESPOŁU PORTOWEGO SZCZECIN–ŚWINOUJŚCIE (STUDIA PRZYPADKÓW)

Słowa kluczowe: żegluga śródlądowa, transport wodny śródlądowy, Zespół Portów Szczecin–Świnoujście

Streszczenie: Artykuł prezentuje analizę konkurencyjności czasowej i kosztowej w trzech gałęziach transportu: drogowym, kolejowym i żegludze śródlądowej. Autorzy starali się wziąć pod uwagę wszystkie koszty związane z transportem. Prezentowane koszty transportu i operacji transportowych pochodzą z kwietnia 2015 roku. Autorzy starali się wykazać przy jakiej klasie drogi wodnej, żegluga śródlądowa będzie konkurencyjna względem innych gałęzi transportu.

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